QUADRANGLE LOCATION

## DESCRIPTION OF MAP UNITS

Surficial geologic mapping of the Chandler Lake quadrangle was based on (1) surface observations of morphology and composition of unconsolidated deposits, (2) distribution and interrelations of terraces, abandoned meltwater channels, moraines, and other landforms, (3) stratigraphic study of exposures along lake shores and river bluffs, and 4) analysis of previously published geologic maps and reports (for example, Detterman, Bickel, and Gryc, 1963; Porter, 1966). The map units are defined on the basis of their character, age, and genesis; most are identical to units mapped previously within the neighboring Chandalar and Philip Smith Mountains quadrangles (Hamilton, 1978a,

The basic stratigraphic framework for the surficial map units is provided by the central Brooks Range glacial sequence of Detterman, Bowsher, and Dutro (1958), with modifications by Porter (1964), Hamilton and Porter (1975), and Hamilton (1978b and in press). Glaciers were generated within the Brooks Range and flowed northward through major valley systems to terminate at and beyond the north flank of the range. Outwash trains were deposited along north-flowing streams that issued from the ice fronts, and loess derived from outwash and other glacial deposits formed blankets beyond the flood-plain margins.

Drift of five major glacial intervals is recognized within the Chandler Lake quadrangle. Gunsight Mountain drift and landforms represent one or more glaciations of probable late Tertiary age. These features have been described y Hamilton (in press), and limits of correlative erratic boulders were mapped by Detterman, Bickel, and Gryc (1963). The Anaktuvuk and Sagavanirktok Glaciations of Detterman, Bowsher, and Dutro (1958) are currently termed Anaktuvuk River and Sagavanirktok River Glaciations to avoid confusion with previously named rock units (Keroher and others, 1966, p. 91 and 3379). The outer limits of Anaktuvuk River drift sheets, the oldest Quaternary glacial deposits, are highlighted on the map by heavy solid lines. The Sagavanirktok River drift, as in its type locality (Hamilton, 1978b), locally forms two units that contrast in postglacial modification and possibly were separated by a nonglacial interval. Itkillik I and II phases are as described by Hamilton and Porter (1975), but the Itkillik II" moraines of those authors are here designated as drift of late Itkillik age. Fan Mountain I and II advances Porter, 1964) are equated with the late Holocene Neoglacial interval as described by Porter and Denton (1967) for

Porter (1964) defined four stades of Itkillik Glaciation based on type localities within the Anaktuvuk Valley. Restudy of these localities indicates that drifts of his Banded Mountain and Antler Valley Stades correspond to Itkillik I and II deposits, respectively, but that deposits of his Anayaknaurak and Anivik Lake Stades do not represent separate glacial readvances (Hamilton, in press). The Alapah Mountain Glaciation of Detterman, Bowsher, and Dutro (1958), Porter (1964), and Hamilton (1978a, b) is not used here. Drift formerly assigned to the Alapah Mountain has been here reinterpreted as alpine moraines of late Itkillik age.

Radiocarbon dates from the neighboring Philip Smith Mountains and Chandalar quadrangles indicate that the Itkillik I glaciation occurred more than 53,000 <sup>14</sup>C years B.P., that late Itkillik readvances took place about 12,500 to 11,500 yr B.P., and that post-Itkillik basin filling had commenced by at least 10,500 yr B.P. in some valleys (Hamilton, 1979a, b). The age of Itkillik II glaciation is uncertain but probably lies largely within the 23,000 to 16,000 yr B.P. time range of late Wisconsin maximum glaciation in the standard North American glacial succession (for example, Dreimanis and Goldthwait, 1973). About 15 radiocarbon dates from the Chardler Lake quadrangle will be available by 1980.

Permafrost probably is present beneath all of the map area. Its upper surface ranges in depth from only a few centimeters in poorly drained deposits beneath thick moss and sod cover to about half a meter in permable coarsegrained sediments and to several tens of meters beneath the larger lakes and rivers. Although exact thicknesses are unknown, records from other parts of the northern Brooks Range and Arctic Foothills (for example, Ferrians, 1965; Williams, 1970) suggest that the base of permafrost probably lies at depths between about 150 and 250 m in most parts of the Chandler Lake quadrangle.

FAN DEPOSITS--Range from very poorly sorted, weakly stratified subangular silty sandy coarse gravel at mouths of tary valleys with relatively gentle gradients. Locally subject to icings during winter (Sloan and others, 1976). Subunit  $f_s$  (SILT FANS) designates unusually fine grained fan deposits, consisting of poorly sorted sandy silt to silty fine sand with peat and silty peat interbeds, along lower course of Ayiyak River.

DEPOSITS OF STEEP ALPINE FANS--Coarse, very poorly sorted, nonstratified to weakly stratified, subangular to subrounded silty sandy gravel at mouths of avalanche chutes and steep canyons near heads of mountain valleys. Upper segments generally channeled, with levees of angular to subangular coarse debris. Subject to snow avalanches during winter (Luckman, 1978), slushflows during spring snowmelt season (Washburn, 1973, p. 164-169), and debris flows during summer (Rapp, 1975). Surface gradients (generally 12°-25°) intermediate between those of alluvial

FAN-DELTA DEPOSITS--Alluvial-fan facies (poorly sorted, weakly stratified, subangular sandy gravel) near valley walls, grading into deltaic and lacustrine facies (well sorted and stratified silt, sand, and fine gravel) near valley centers. Occur in moraine-dammed basins within Chandler and Anaktuvuk Valleys. Locally subject to icings. OTHER ALLUVIAL DEPOSITS

ALLUVIUM, UNDIFFERENTIATED--Ranges from poorly sorted, moderately well stratified, subangular coarse gravel near heads of mountain valleys to moderately well sorted gravelly sand and sandy fine gravel along slow-flowing stretches of Ayiyak River and moraine-dammed segments of Chandler, Anaktuvuk, and Itkillik Valleys. Includes fan, flood-plain, and low terrace deposits too small to be designated separately.

MODERN ALLUVIUM--Sand and gravel, as described above; generally unvegetated and commonly subject to icings. Differentiated only along major valleys. LOW ALLUVIAL TERRACE DEPOSITS--Sand and gravel, as described above; mantled with up to 1.5 m of silt, sand or peat;

INTERGLACIAL TERRACE GRAVEL OF POST-ANAKTUVUK RIVER AGE--Oxidized sandy gravel, containing residual erratic boulders, forming terraces 45 to 65 m above modern stream levels. Generally caps erosion surfaces formed within Anaktuvuk River drift sheets but lying beyond outer moraines of Sagavanirktok River Glaciation and above outwash terraces INTERGLACIAL TERRACE GRAVEL OF PRE-ANAKTUVUK RIVER AGE--Oxidized sandy gravel, as described above, forming terraces

80 to 110 m above modern stream levels. Generally caps erosion surfaces formed within drift limits of Gunsight

Mountain glacial interval but lying beyond outer moraines and above outwash terraces of Anaktuvuk River Glacia-PREGLACIAL TERRACE GRAVEL--Strongly weathered sandy gravel of inferred Tertiary age forming terracelike erosion

remnants 100 to 150 m above modern stream levels. Caps highest erosion surfaces beyond limits of Gunsight Mountain glacial interval. LACUSTRINE DEPOSITS

granules and pebbles. Differentiated only along east side of Anaktuvuk Valley north of range front.

LACUSTRINE DEPOSITS, UNDIFFERENTIATED--Well stratified clay, silt, and sand, grading into sand and gravelly sand near former shorelines and sandy fine gravel near former stream mouths. Extensive thick deposits occur behind Itkillik-age moraines along floors of Chandler, Anaktuvuk, and Itkillik Valleys. Shown only by stippled map pattern where buried beneath alluvium, solifluction and fan deposits, and sand sheets. Include beach deposits too small to be designated separately. BEACH DEPOSITS--Nonstratified to well stratified fine gravel and sandy fine gravel containing subrounded to rounded

COLLUVIAL DEPOSITS LANDSLIDE DEPOSITS--Unsorted nonstratified coarse to fine angular rubble forming tongues and lobes associated with detachment scars and slide tracks on high, steep walls of mountain valleys. Subject to episodes of rapid down-slope motion and long periods of relative stability. Most common on lower (shale) member of Karayut Conglomerate; also locally on limestone, shale, and massive middle member of Kanayut Conglomerate.

FLOW-SLIDE DEPOSITS--Very poorly sorted, angular, generally tabular rubble in abundant muddy matrix. Forms lobes subject to slow and probably continuous downslope motion, generally associated with arcuate detachment scars. Most common on shale and bentonite of Cretaceous Seabee and Prince Creek Formations, as mapped by Detterman and ACTIVE TALUS RUBBLE--Angular, unsorted, nonstratified rock debris forming cones and aprons more than 2 m thick along lower walls of mountain valleys and in cirques at valley heads. Also forms thin (less than 1-2 m) and

generally discontinuous sheets over many uplands mapped as "bedrock". Generally unvegetated, unweathered to slightly weathered, and with lichen cover sparse to absent. Subject to rockfalls, especially during spring INACTIVE TALUS RUBBLE--Angular rock debris, as described above, generally weathered and lichen covered, and with partial sod cover at some localities. Thin (less than 1-2 m) blankets of stabilized talus occur on some up-

lands north of the Brooks Range (see stippled bedrock pattern). SOLIFLUCTION DEPOSITS--Very poorly sorted, nonstratified to weakly stratified stony sandy silt and organic silt in sheets and aprons more than 1-2 m thick. Forms widespread deposits on gentle to moderate slopes beyond limits of Anaktuvuk River Glaciation; locally present on Anaktuvuk River drift and on slopes eroded into it Present on deposits of Sagavanirktok River and younger age but rarely of sufficient extent or thickness to con-

stitute a mappable unit. Subunit (s) designates thin (less than about 1.5 m) but widespread and generally continuous solifluction blan-ROCK-GLACIER DEPOSITS, ACTIVE--Very poorly sorted, nonstratified, coarse angular rock debris, commonly with matrix of silt and fine rubble. Contains abundant interstitial ice. Upper surfaces generally unvegetated, unweathered

to moderately weathered, and with sparse to moderate lichen cover. Frontal slopes barren, steep, and unstable, meeting upper surfaces at abrupt angle. Form (1) lobate deposits at bases of talus cones along valley walls and (2) tongue-shaped deposits within cirques (see White, 1976). The tongue-shaped variety commonly overlies stagnant glacier ice (Ellis and Calkin, in press). Subject to slow downslope motion. ROCK-GLACIER DEPOSITS, INACTIVE--Coarse angular rock debris, as described above, but lacking interstitial ice. Upper surfaces and frontal slopes weathered, lichen covered, and commonly bear partial sod or vegetation cover.

PROTALUS RAMPART DEPOSITS--Unsorted, nonstratified, coarse, angular rock debris forming arcuate low ridges at bases of cirque headwalls. Associated with persisting snowbanks in shaded sites. Subject to rockfalls during spring POLYGENETIC SAND AND SILT DEPOSITS

Frontal slopes grade into upper surfaces without abrupt angles.

SAND DEPOSITS--Moderately sorted fine to medium sand, horizontally bedded to slightly cross bedded, commonly with thin interbeds of sandy peat or organic silty fine sand. Deposited initially by slow-moving streams within basins partly dammed by end moraines in Anaktuvuk, Alapah, and Itkillik Valleys and in North Fork of Koyukuk Valley. Upper 0.5 to 5 m locally reworked by wind into sand sheets and dunes. Commonly grade downward into lacustrine deposits (see stippled map pattern).

UPLAND SILT DEPOSITS--Moderately sorted, generally unstratified silt, organic silt, and slightly clayey or stony silt on uplands of low to moderate relief north of oldest drift limits and above levels of oldest terrace deposits. Formed largely of loess, mixed by frost action with variable amounts of in situ organic matter and weathering products. Grades laterally into solifluction deposits on slopes steeper than about 1°-2°

ORGANIC SILT DEPOSITS--Weakly stratified sandy silt, organic silt, and silty peat, containing abundant ice in form of lenses, wedges, and interstitial grains. Fills poorly drained topographic depressions and valleys of under

fit streams beyond limits of Gunsight Mountain and Anaktuvuk River drift sheets; locally present on drift bodies older than Itkillik age. Formed largely of loess, with admixed organic and solifluction deposits. Subunit (si) designates thin (less than 1-2 m) organic silt deposits above near-surface alluvium along valley floors of Tundra and Autumn Creeks and Tuluga River. GLACIAL DEPOSITS

Fan Mountain Glaciation (Neoglaciation) FAN MOUNTAIN DRIFT, UNDIFFERENTIATED--Unsorted, nonstratified, coarse to fine angular rubble in circues and valley heads. Designates (1) remnants of eroded Fan Mountain drift unassignable to either Phase I or II and (2) com-

posite Fan Mountain drift bodies too small for subdivision. DRIFT OF FAN MOUNTAIN PHASE II -- Angular rubble, as described above, forming lobes and arcuate ridges of ice-cored drift with steep, unstable frontal slopes. Unvegetated, unweathered to slightly weathered, and with lichens sparse to absent. Restricted to cirques and generally associated with active glaciers. DRIFT OF FAN MOUNTAIN PHASE I--Angular rubble, as described above, forming eroded lobes and ridges with stable frontal slopes. Generally weathered and lichen covered, with partial sod cover in some localities.

ITKILLIK DRIFT, UNDIFFERENTIATED--Unsorted to poorly sorted, generally nonstratified till, ranging in composition from muddy sandy gravel to clayey stony silt, with local stratified ice-contact deposits consisting of moder-ately sorted sand and sandy gravel. Contains faceted and striated stones up to boulder size. Designates thick (greater than 3 m) drift deposits, usually within mountain valleys, that cannot be assigned to a specific

Itkillik Glaciation

DRIFT OF LATE ITKILLIK AGE--Till and stratified ice-contact deposits, as described above. Forms sharp-crested end moraines, irregular ground moraine, and steep-sided ice-contact stratified drift deposits in most mountain valleys. Forms unusually subdued moraines and silty till of probable redeposited lacustrine sediments in Anaktuvuk Valley north of range front. Loess cover generally absent, and exposed stones very slightly weathered. Subunit im (MELTWATER DEPOSITS) designates extensive kames, kame terraces, and esker complexes consisting generally of sandy gravel that formed in contact with stagnating glacier ice in Anaktuvuk Valley south of range

DRIFT OF ITKILLIK PHASE II--Till and stratified ice-contact deposits, as described above, with ice-contact deposits more abundant than till in most valleys. Forms sharply defined drift lobes with prominent knob and kettle morphology and conspicuously channeled outwash trains. Crests and upper slopes lack loess and solifluction cover, and exposed boulders and cobbles exhibit slight to moderate weathering. Most swales lack solifluction deposits, and abandoned meltwater channels commonly are floored with lichen-covered coarse gravel. Unstable kettles with actively caving gravel rims near Anaktuvuk River and Natvakruak Lake suggest that Phase II drift may still be partly ice cored.

within Phase II drift sheet west of Natvakruak Lake. Contemporaneity with Phase II outwash on Phase I morine between Anaktuvuk and Kanayut Valleys indicates that Phase I drift was still partly ice cored at time DRIFT OF ITKILLIK PHASE I--Till and stratified ice-contact deposits, as described above, with till predominating in most valleys. Forms closely spaced concentric end moraines with flanking slopes up to 20°-25° and subdued knob and kettle topography; associated with outwash trains partly obscured by solifluction. Moraine crests generally bare of loess, but upper slopes are blanketed by 0.5 to 2 m of stony organic silt (loess and colluvi-

Subunit ik, (KAME DEPOSITS) designates unusually extensive and thick (greater than 30 m) deposits of moderately

well to well sorted sandy gravel, usually with less than 0.2 m cover of silt, organic silt, or sod. Formed

Exposed cobbles and boulders moderately to heavily weathered. Swales partly filled with 1-3 m of ice-

rich organic silty solifluction deposits. Subunit  $ik_1$  (KAME DEPOSITS) designates unusually extensive and thick (greater than 30 m) deposits of moderately well sorted sandy gravel containing scattered small boulders. Contemporaneity with Phase I outwash west of Anaktuvuk River suggests presence of older residual glacier ice at time of Phase I advance in Anaktuvuk Valley. ITKILLIK OUTWASH, UNDIFFERENTIATED--Moderately well sorted and stratified sandy gravel, forming aprons and valley

trains in front of Itkillik moraines and isolated terrace remnants farther downvalley. Largest stones decrease in size from subrounded cobbles and small boulders near moraine fronts to subrounded to rounded pebbles and cobbles farther downvalley.

OUTWASH OF LATE ITKILLIK AGE--Sandy gravel, as described above, generally without loess or peat cover. Forms aprons and valley trains in front of late Itkillik moraines. Terraces are as high as 15 m near moraine fronts and generally merge downvalley with outwash terraces of Phase II. OUTWASH OF ITKILLIK PHASE II--Sandy gravel, as described above, generally lacking loess. Forms extensive aprons and valley trains in front of Itkillik II moraines. Terraces are as high as 25 m near moraine fronts; decrease

OUTWASH OF ITKILLIK PHASE I--Sandy gravel, as described above, generally with thin to moderate (0.5 to 3 m) loess and solifluction cover. Forms aprons and valley trains in front of Itkillik I moraines. Terraces up to 40 m high near moraine fronts; 5-10 m high farther downvalley. Commonly incised within Sagavanirktok-age drift and dissected in turn by Itkillik II outwash.

INWASH DEPOSITS--Moderately well sorted and stratified gravelly sand and sandy fine gravel with loess and sod cover thin to absent (less than 0.2 m) and lacking solifluction deposits. Forms large familike deposit that abuts against east flanks of Itkillik II and late Itkillik drift sheets near range front west of Shainin Lake. Represents alluvium deposited against glacier margin by streams of nonglacial origin. Sagavanirktok River Glaciation

SAGAVANIRKTOK RIVER DRIFT, UNDIFFERENTIATED--Poorly sorted nonstratified till, ranging in composition from silty sandy bouldery gravel to clayey stony silt, with local deposits of modernately well sorted ice-contact gravel. Erratic boulders sparse (1-3 per km²), generally protrude less than 0.5 m above ground surface, and are composed only of quartzite and conglomerate of the Kanayut Conglomerate. Forms distinct but subdued end moraines and ground moraine with most crests and flanks covered by continuous blanket of organic silt (loess and solifluction deposits). Swales and kettles generally contain more than 5 m of ice-rich organic silt (colluvial and lacustrine deposits). Some ridge crests locally lack silt cover, exposing weathered subrounded gravel of resistant lithologies. Broadly dissected along major rivers, with depth of erosion 30-45 m. Subunit (sd) designates thin (0.5 to 3 m) and generally discontinuous deposits above bedrock at any near north

DRIFT OF YOUNGER SAGAVANIRKTOK RIVER AGE--Till and ice-contact gravel, as described above, along west flank of Itkillik Valley and within valley of May Creek. Forms subdued end moraine and ground moraine with many ridge crests bare of loess and solifluction cover. Swales and kettles more abundant and less modified than on older deposits of Sagavanirktok River age.

DRIFT OF OLDER SAGAVANIRKTOK RIVER AGE--Glacial deposits of unknown composition forming distinct but very subdued and deeply dissected ridges along west flank of Itkillik Valley and along valley of May Creek. Ridge crests and flanks bear generally continuous cover of organic silt. SAGAVANIRKTOK RIVER OUTWASH, UNDIFFERENTIATED--Moderately well sorted and stratified sandy gravel, with largest stones generally decreasing in size from subrounded cobbles and small boulders near moraine fronts to subrounded

30-40 m along most valleys. YOUNGER OUTWASH--Sandy gravel, as described above, forming outwash trains originating at outer limits of younger Sagavanirktok River moraines.

OLDER OUTWASH--Sandy gravel, as described above, forming outwash trains originating at outer limits of older Sagavanirktok River moraines. Anaktuvuk River Glaciation

DRIFT--Glacial deposits of unknown composition. Overlain by continuous cover of organic silt (loess and solifluction deposits) more than 2-3 m thick. Erratic boulders very sparse (generally <1 per km²), generally protrude less than 0.2 m above ground surface, and consist only of most resistant (thick-bedded and nonferruginous) facies of Kanayut Conglomerate. Forms very subdued till plains and low broad morainal ridges with extremely gentle (1°-2°) flanking slopes. Former swales and kettles generally entirely filled with ice-rich, silty, organic colluvial and lacustrine deposits more than 5 m thick. Deeply and broadly dissected by minor as well as major streams, with depth of dissection 45-60 m along most valleys. Forms oldest continuous drift sheets

Subunit (ad) designates thin (0.5 to 3 m) and generally discontinuous deposits above bedrock. OUTWASH--Oxidized gravel of uncertain composition forming outwash trains originating at outer limits of drift sheets of Anaktuvuk River age. Generally overlain by 2-5 m of organic silt (frost-churned loess and solifluction deposits).

to rounded pebbles and cobbles farther downvalley. Generally overlain by 1-3 m of organic silt (loess and soliffluction deposits). Commonly associated with underfit or abandoned stream courses and dissected to depth of

Gunsight Mountain Glacial Interval DRIFT--Highly eroded glacial deposits of unknown composition, lacking primary relief and overlain by continuous cover of organic silt generally more than 2-3 m thick. Occurs beyond limits of Anaktuvuk River drift (marked by heavy solid lines) near Nanushuk River and near Gunsight Mountain, where it is associated with abundant erratics of resistant Kanayut Conglomerate facies on postglacial erosion surfaces and with rock-cut channels and benches probably eroded by glacial meltwater streams. Probably present between Chandler and Siksikpuk Rivers, where arcuate belt of erosion remnants may define former ice limit. Deeply and broadly dissected, with depth of erosion 60-80 m along most valleys.

Subunit (Tga) designates thin (0.5 to 2 m) and generally discontinuous deposits above bedrock. OUTWASH--Highly weathered and eroded gravel of uncertain composition forming outwash trains and aprons originating

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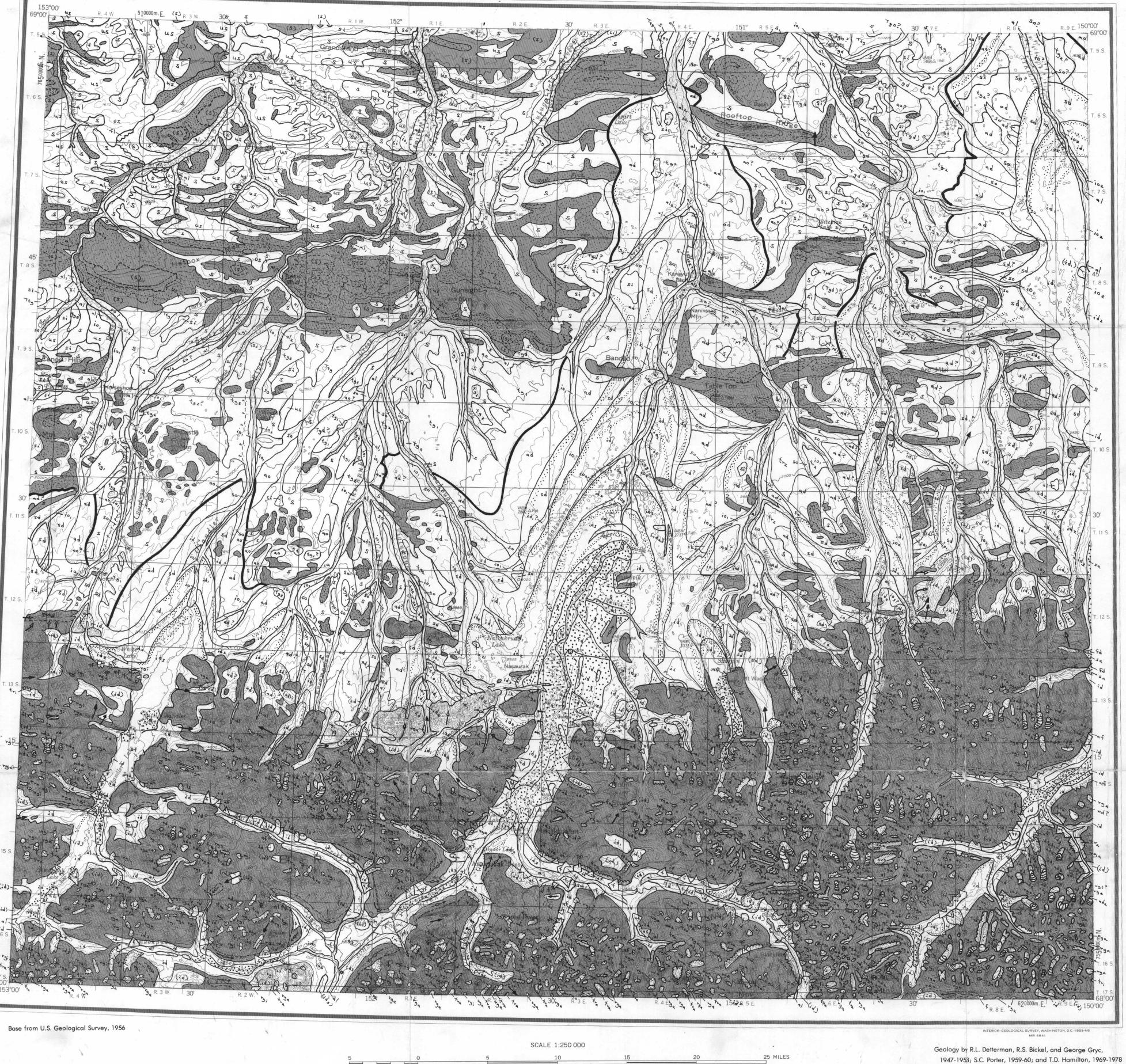
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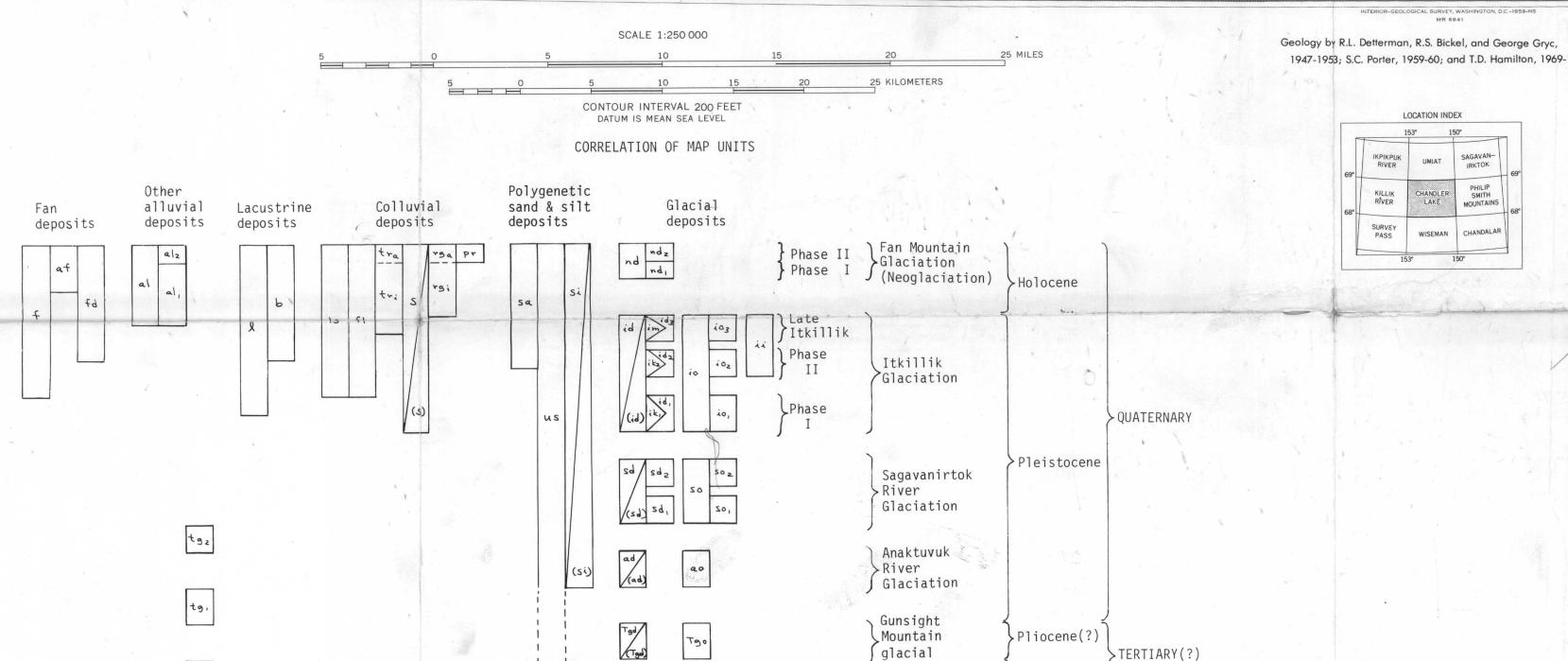
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GEOLOGIC SYMBOLS

Bedrock - Stippled where covered Thin and generally discontinuous Morainal ridge by thin talus, solifluction, and deposit above bedrock loess deposits Geologic contact - Dashed where -----?-?gradational; queried where Ice-scoured bedrock - Showing approximate direction of ice movement or meltwater drainage Outer limit, drift sheets of Anaktuvuk River age Direction of glacier flow across Glacier - Curved lines concave downvalley Direction of glacial meltwater flow across topographic divide Surface and subsurface or ridge spur lacustrine deposits





interval

Miocene(?)

## SURFICIAL GEOLOGIC MAP OF THE CHANDLER LAKE QUADRANGLE, ALASKA

Thomas D. Hamilton